

## CLAIMS

What is claimed is:

1. A method for summing integrals at a target frequency of a plurality of target frequencies, the method comprising the computer-implemented steps of:
  - accessing a set of pairs of I and Q correlation values corresponding to a set of data blocks, wherein:
    - the set of data blocks together make up a sampled data that is associated with a received signal;
    - each pair of I and Q correlation values from the set of pairs of I and Q correlation values corresponds to a calculated pair of I and Q correlation integrals that are integrated over one corresponding data block from the set of data blocks at a plurality of frequencies from a set of frequencies; and
  - selecting pairs of I and Q correlation values that correspond to calculated pairs of I and Q correlation integrals that are calculated using a frequency from the set of frequencies that is close to the target frequency to be selected pairs I and Q correlation values;
  - weighting the selected pairs of I and Q correlation values according to a set of characteristics to produce a set of weighted pairs of I and Q correlation values;
  - and
  - summing the weighted pairs of I and Q correlation values at the target frequency.

2. A method for summing integrals for a sampled data, the method comprising the computer-implemented steps of:

step A: defining R number of sets of frequencies, wherein:

- R is an integer value that is greater than unity;
- each set of frequencies from the R number of sets of frequencies is assigned an index that is unique, wherein the index ranges in value from 1 to R;

step B: defining R number of sets of data blocks, wherein:

- each set of data blocks from the R number of sets of data blocks make up the sampled data;
- each set of data blocks from the R number of sets of data blocks is assigned the index that is unique, wherein the index ranges in value from 1 to R;

step C: defining R number of pairs of data block-frequency sets, wherein:

- each pair of data block-frequency sets from the R number of pairs of data block-frequency sets is assigned the index that is unique, wherein the index ranges in value from 1 to R; and
- each pair of data block-frequency sets comprises a set of data blocks from the R number of sets of data blocks and a set of frequencies from the R number of sets of frequencies, wherein:
  - the index of the pair of data block-frequency sets, the index of the set of data blocks in the pair of data block-frequency sets and the index of the set of frequencies in the pair of data block-frequency sets have identical values;



45                   step K: selecting pairs of I and Q correlation values that correspond to the  
46                   subset of data blocks at the identified frequency to be selected pairs of  
47                   I and Q correlation values;  
48                   step L: for the selected data block, weighting the selected pairs of I and Q  
49                   correlation values with weights to form weighted pairs of I and Q  
50                   values;  
51                   step M: summing the weighted pairs of I and Q values over the selected block  
52                   to form weighted sums of I and Q values;  
53                   step N: repeating steps I through N until all the frequencies from the current  
54                   pair of data block-frequency sets have been selected to be the target  
55                   frequency;  
56                   step O: repeating steps G through O until all the data blocks from the current pair of  
57                   data block-frequency sets have been selected to be the selected data block;  
58                   step P: repeating steps F through O until all the pairs of data block-frequency sets  
59                   from the R number of pairs of data block-frequency sets have been selected to  
60                   be the current pair of data block-frequency sets.

- 1    3.    The method of Claim 2, wherein calculating pairs of I and Q correlation integrals is  
2           performed coherently by using a navigation bit information when the I and Q  
3           correlation integrals are associated with a received signal that emanated from a global  
4           positioning satellite vehicle, and wherein the navigation bit information is associated  
5           with the global positioning satellite vehicle.

1 4. A method for summing integrals for a sampled data, the method comprising the  
2 computer-implemented steps of:  
3 step A: defining a first set of frequencies and a second set of frequencies;  
4 step B: defining a first set of data blocks and a second set of blocks, wherein;  
5 each set of data blocks make up the sampled data;  
6 step C: defining a first pair of data block-frequency set, wherein:  
7 the first pair of data block-frequency set comprises the first set of data blocks  
8 and the first set of frequencies;  
9 step D: defining a second pair of data block-frequency set, wherein:  
10 the second pair of data block-frequency set comprises the second set of data  
11 blocks and the second set of frequencies;  
12 step E: selecting the first pair of data block-frequency set;  
13 step F: for each data block in the first pair of data block-frequency set, calculating a  
14 pair of I and Q correlation integrals at each frequency in the first pair of data  
15 block-frequency sets to produce a corresponding pair of I and Q correlation  
16 values;  
17 step G: from the second pair of data block-frequency set, selecting one data block that  
18 has not been previously selected from the second pair of data block-frequency  
19 sets to be a selected data block and performing the steps of:  
20 step H: from the first pair of data block-frequency set, identifying a subset of  
21 data blocks make up the selected data block;  
22 step I: selecting a frequency that has not been previously selected from the  
23 second pair of data block-frequency set to be a target frequency;

step J: from the first pair of data block-frequency set, identifying a frequency that is close in value to the target frequency to be an identified frequency;

step K: selecting pairs of I and Q correlation values that correspond to the subset of data blocks from the first pair of data block-frequency set to be selected pairs of I and Q correlation values;

step L: for the selected data block, weighting the selected pairs of I and Q correlation values with weights to form weighted pairs of I and Q values;

step M: summing the weighted pairs of I and Q values over the selected block to form weighted sums of I and Q values;

step N: repeating steps I through N until all the frequencies from the current pair of data block-frequency sets have been selected to be the target frequency; and

step O: repeating steps G through O until all the data blocks from the second pair of data block-frequency set have been selected to be the selected data block.

5. The method of Claim 4, wherein calculating pairs of I and Q correlation integrals is performed coherently by using a navigation bit information when the I and Q correlation integrals are associated with a received signal that emanated from a global positioning satellite vehicle, and wherein the navigation bit information is associated with the global positioning satellite vehicle.

1 6. The method of Claim 6, wherein calculating pairs of I and Q correlation integrals is  
2 performed coherently by using a navigation bit information when the I and Q  
3 correlation integrals are associated with a received signal that emanated from a global  
4 positioning satellite vehicle, and wherein the navigation bit information is associated  
5 with the global positioning satellite vehicle.

1 7. A method for estimating a carrier frequency at a target frequency, the method  
2 comprising the computer-implemented steps of:  
3 receiving sampled data associated with a received signal;  
4 dividing a range of frequency of interest into a first set of frequency intervals and a  
5 second set of frequency intervals;  
6 dividing the sampled data into a set of blocks of data based on the first set of  
7 frequency intervals;  
8 for each data block of the set of blocks of data, calculating I and Q correlation  
9 integrals associated with the sampled data at one representative frequency  
10 from each frequency interval in the first set; and  
11 for every frequency interval of the second set of frequency intervals, determining a  
12 corresponding selected frequency in the first set of frequency intervals,  
13 wherein the selected frequency is close in value to the target frequency;  
14 selecting I and Q correlation integrals corresponding to each selected frequency to be  
15 selected I and Q correlation integrals

16 weighting the selected pairs of I and Q correlation values according to a set of  
17 characteristics to produce a set of weighted pairs of I and Q correlation values;  
18 and  
19 summing the weighted pairs of I and Q correlation values at the target frequency.

1 8. The method of Claim 7, wherein the received signal is from a known signal source.

1 9. The method of Claim 7, wherein for each data block of the set of data blocks, the step  
2 of calculating I and Q correlation integrals comprises calculating the I and Q  
3 correlation integrals for each hypothesized delay value over a range of hypothesized  
4 delay values.

1 10. The method of Claim 9, further comprising the step of selecting a trial frequency  
2 value for each frequency interval of the first set of frequency intervals for calculating  
3 the I and Q correlation integrals.

1 11. The method of Claim 10, wherein the trial frequency value is a frequency value at a  
2 mid-point of each frequency interval.

1 12. The method of Claim 7, wherein the carrier frequency contains at least one frequency  
2 shift that is a member of a set of frequency shifts, wherein the set of frequency shifts  
3 include a zero frequency shift, a positive frequency shift and a negative frequency  
4 shift.



1 13. The method of Claim 7, further comprising the steps of:  
2 for each hypothesized delay value in a range of hypothesized delay values, calculating  
3 a magnitude of a vector (I,Q) of correlation sums that were previously  
4 summed over all the blocks of data for each frequency interval of the second  
5 set of frequency intervals; and  
6 determining an estimate of the carrier frequency by identifying a particular frequency  
7 interval from the second set of frequency interval that has a highest magnitude  
8 calculation.

1 14. The method of Claim 7, wherein the first set of frequency intervals is a coarse grain  
2 set of frequency intervals and the second set of frequency intervals is a fine grain set  
3 of frequency intervals.

1 15. The method of Claim 7, wherein a number of intervals in the first set of frequency  
2 intervals is proportional to a length of the sampled data and is based on a pre-selected  
3 signal-to-noise ratio.

1 16. The method of Claim 7, wherein a number of intervals in the second set of frequency  
2 intervals is proportional to a length of the sampled data.

1 17. The method of Claim 7, wherein a range of frequency of interest is based on a pre-  
2 selected frequency interval around a frequency of a known signal source from which  
3 the received signal emanates.

1 18. The method of Claim 7, wherein calculating the I correlation integral and the Q  
2 correlation integral is performed coherently by using a navigation bit information  
3 when the received signal emanates from a global positioning satellite vehicle, wherein  
4 the navigation bit information is associated with the global positioning satellite  
5 vehicle.

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